

Beyond Chatbots:

Towards Truly Intelligent Conversational Agents

Peter Voss

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Peter Voss: Founder, CEO & Chief Scientist

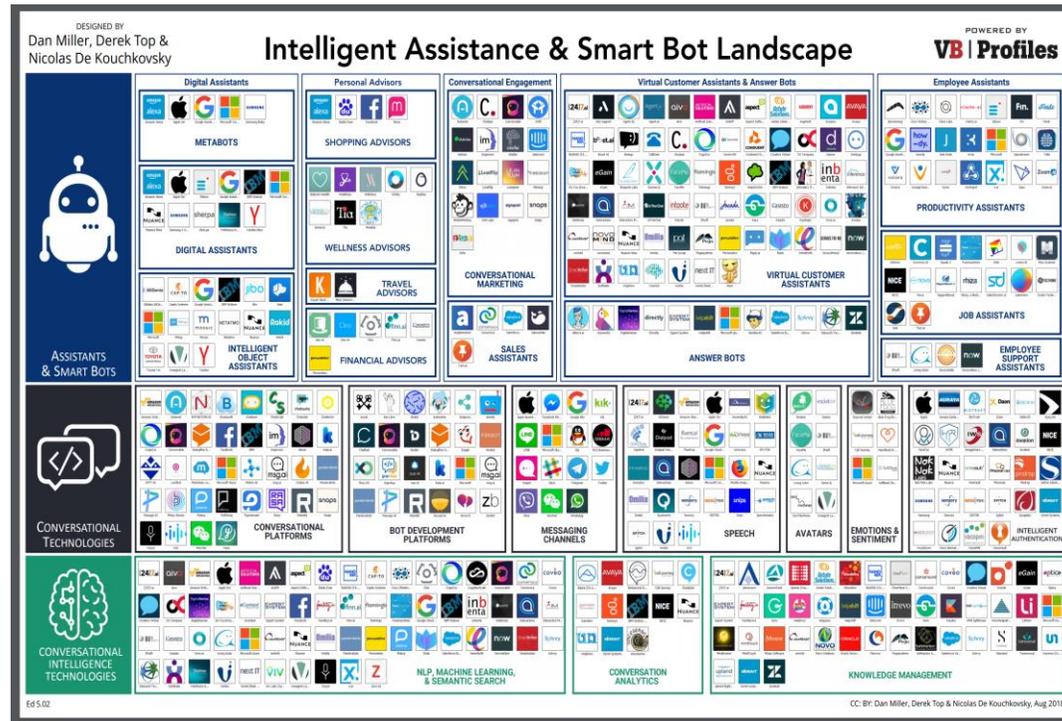


- ❑ Built several technology platforms & technology companies
- ❑ Coined the term 'Artificial General Intelligence' (AGI) in 2001
- ❑ 15+ years of developing advanced Conversational AI
- ❑ Created & commercialized 'AI for Call Centers' through

SmartAction Company

SmartAction
Automating Calls. Intelligently.

The Problem: Current Chatbots Inherently can not...



- Remember
- Learn
- Understand
- Reason
- Converse
- Personalize

State-of-the-Art Chatbot: Alexa

Play video: <https://vib.by/v/712HxEiWP>

Scene 1 - Alexa

Alexa, add chips and guac, napkins and 3 bottles of wine to John's birthday list



I added chips and guac napkins 3 bottles of wine to your shopping list



Alexa cannot handle new/ multiple lists

Actually Alexa, remove napkins from the list



To clear your list or remove an item, visit the Alexa app



Alexa cannot change items on list

Ok, then



Alexa, what do I have on John's birthday list?



You have 1 item on your shopping list chip and guac napkins 3 bottles of wine



Alexa thinks this is just one item

You call that 1 item?



Alexa, remember that John's favorite cake is Red Velvet

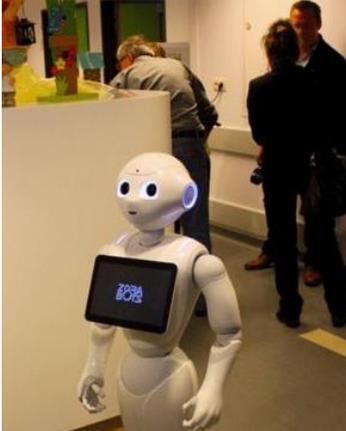
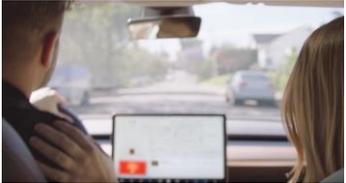


I'm not quite sure how to help you with that



Cannot remember simple new information

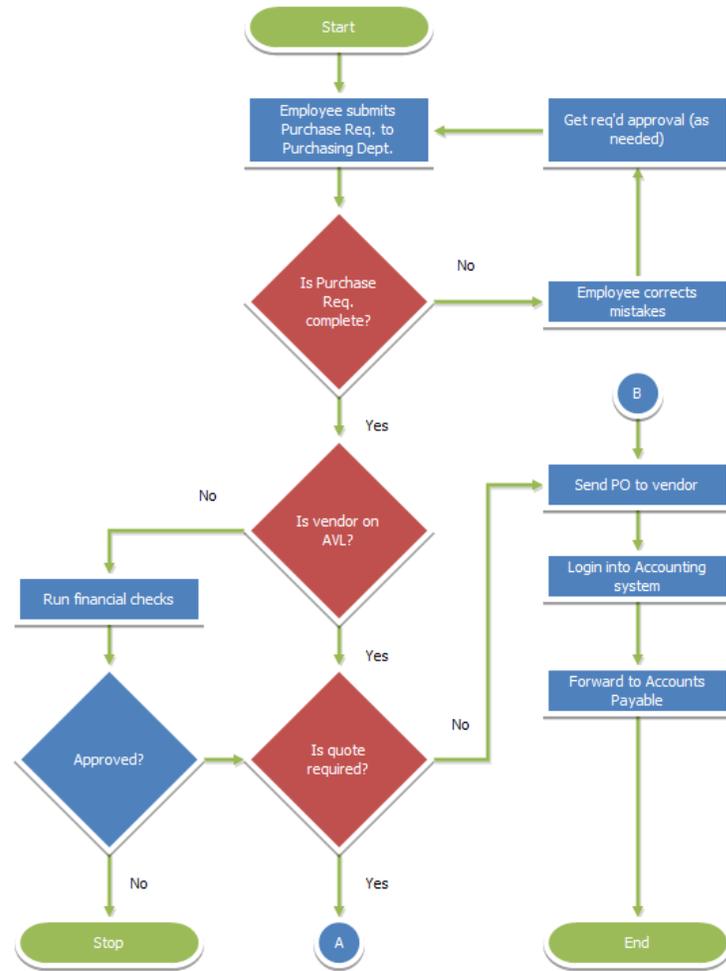
Demand for *Personalized* Natural Language Intelligence...



DARPA's Three Waves of AI

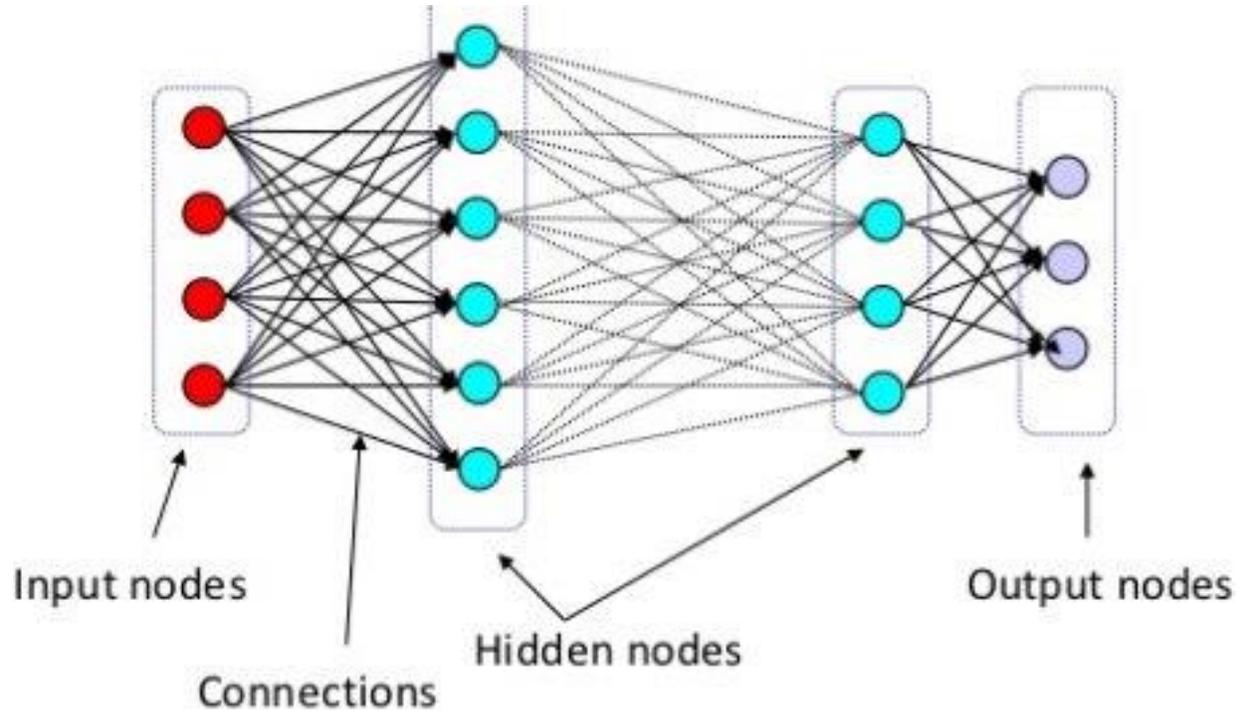


First Wave – Traditional Programming



Combinatorial Explosion
in trying to handle
Language Understanding
& ongoing Conversation

Second Wave – Neural Nets - Big Data



Excellent solution for problems that have/require large amounts of data to categorize and/or predict – and where *static* statistical models and accuracy suffice.

Not suitable for deep Language Understanding or ongoing Conversation

Limitations of Second Wave: The Experts Agree...



On backpropagation:
"My view is throw it all away and start again."

"The future depends on some graduate student who is deeply suspicious of everything I have said."

Geoffrey Hinton
"Godfather of Deep Learning"



Google Deepmind co-founder Demis Hassabis.
Image: Google

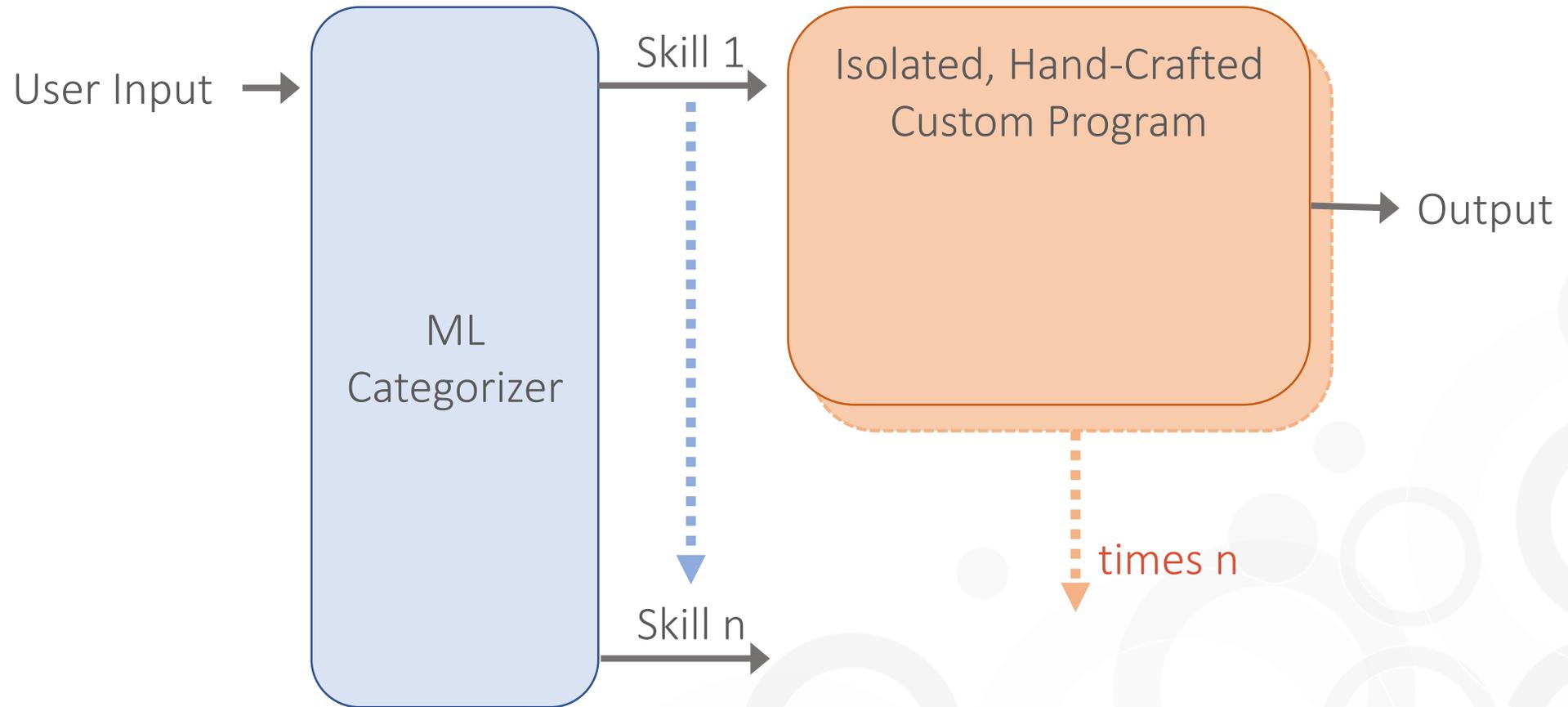
"Deep learning is an amazing technology... but definitely not enough to solve AI... not by a long shot" – Sept 2018



"Current AI methods are statistically impressive but individually unreliable." – Feb 2017

**DEFENSE ADVANCED
RESEARCH PROJECTS AGENCY**

Chat-Bot Technology



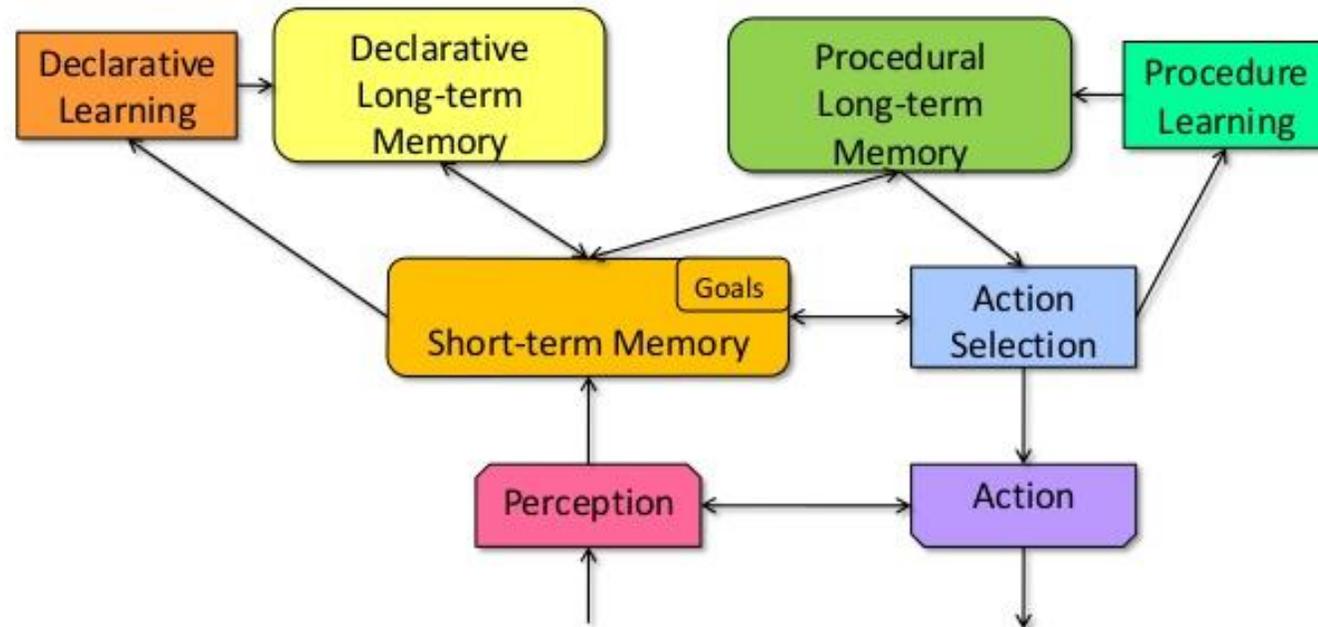
Third Wave – Cognitive Architectures

“...hypothesis about the fixed structures that provide a mind... and how they work together – in conjunction with knowledge and skills embodied within the architecture – to yield intelligent behavior in a diversity of complex environments.”

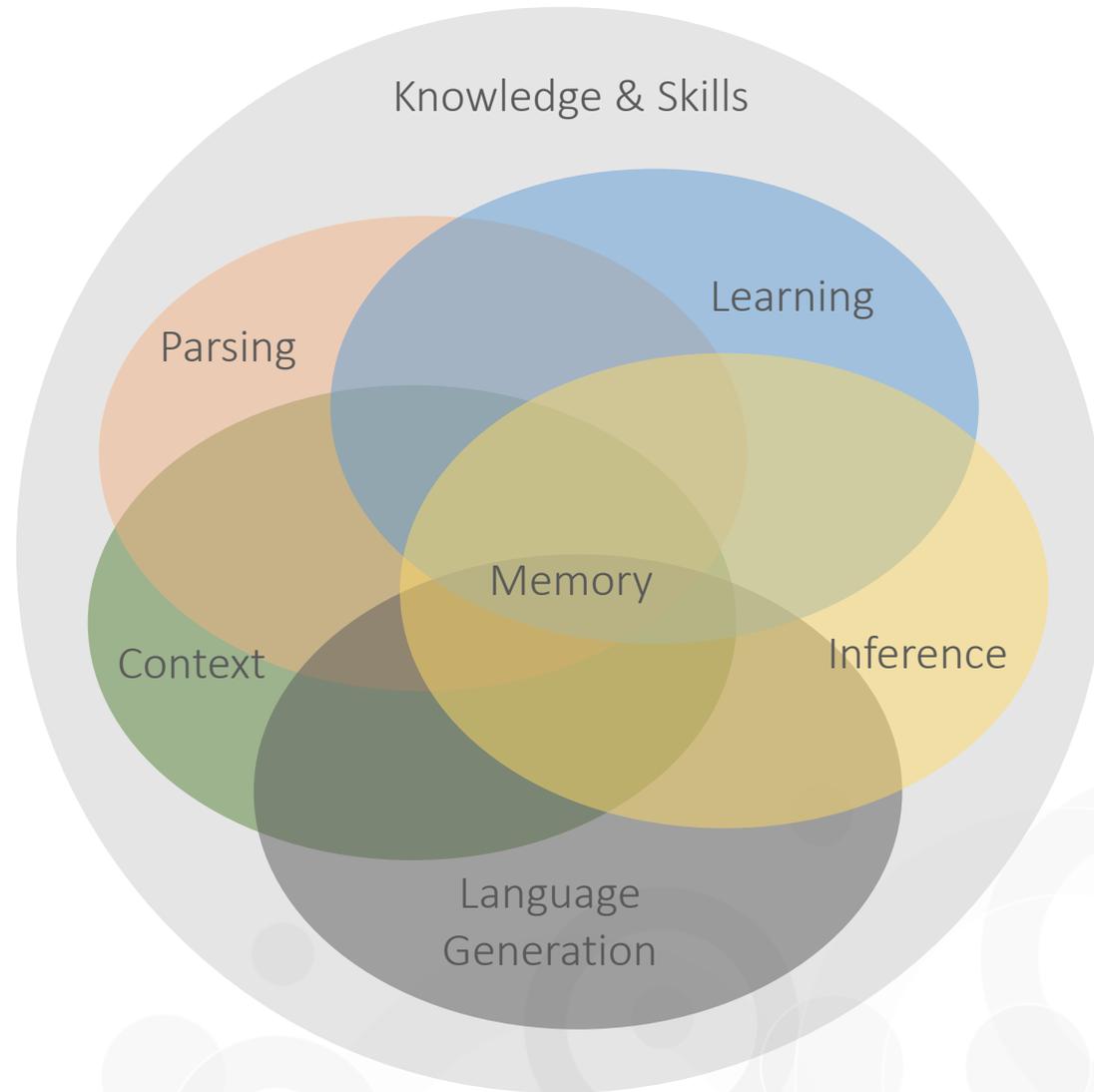
– Wikipedia

Third Wave – Cognitive Architectures

Common Structures of many Cognitive Architectures



Highly Integrated Cognitive Architecture



Intelligent Interactions

Understanding

- Meaning and implications of words
- Entity resolution

Memory

- Short-term memory & context
- Conceptual long-term memory

Adaptivity

- Unsupervised, one-shot learning
- Real-time skill learning

Reasoning

- Disambiguation & Questions Answering
- Explaining answers & actions

Conversation Management

- Conversation Context & Goals
- Disambiguation & Meta-Cognition

Cognitive Architecture Technology: Aigo

Hyper-personalized
Conversational AI

Play Video: <https://vib.by/v/X1x1QVs-w>

Scene 1 - Aigo

AIGO

Hi there, what's on your mind?

Alright, let's make this happen. Aigo



Add multiple items to a new list

Add chips and guac, napkins and 3 bottles of wine to John's birthday list



Learns new synonym

AIGO

Good morning Sam, I don't know what guac is.

Guac is the same as guacamole



Allows and confirms new list creation

AIGO

Creating John's birthday list. Is that OK?

Yes



AIGO

Ok, I added chips and guacamole, napkins and 3 bottles of wine to John's birthday list

AIGO Chips and guacamole and 3 bottles of wine

What food is on that list again?



Filters items by food (or other) category

Actually, make it 5 bottles



Easily change quantity of items on list

AIGO Sure. The list is now 5 bottles of wine, chips and guacamole and napkins

Great. Send John's birthday list to June, and ask her if I am missing anything please.



Multiple commands: send list and ask June

AIGO Sending John's birthday list to June via email

Wait, always contact June by Skype



Aigo learns new default channel for June

AIGO Ok, sending the list to June via Skype

Oh, and remember that John's favorite cake is Red Velvet



Aigo learns unstructured information

AIGO Got it

Fantastic



Deep Natural Language Understanding and Meaningful, Ongoing Conversation

Remind me to speak with Jane. (reminder)

Remind me what did Jane say? (tell me)

Remind Jane to talk to me. (ask Jane)

(Different meanings and responses to 'remind')

My sister's cat Spock... is pregnant.

(A five-year old immediately learns 5 new facts)

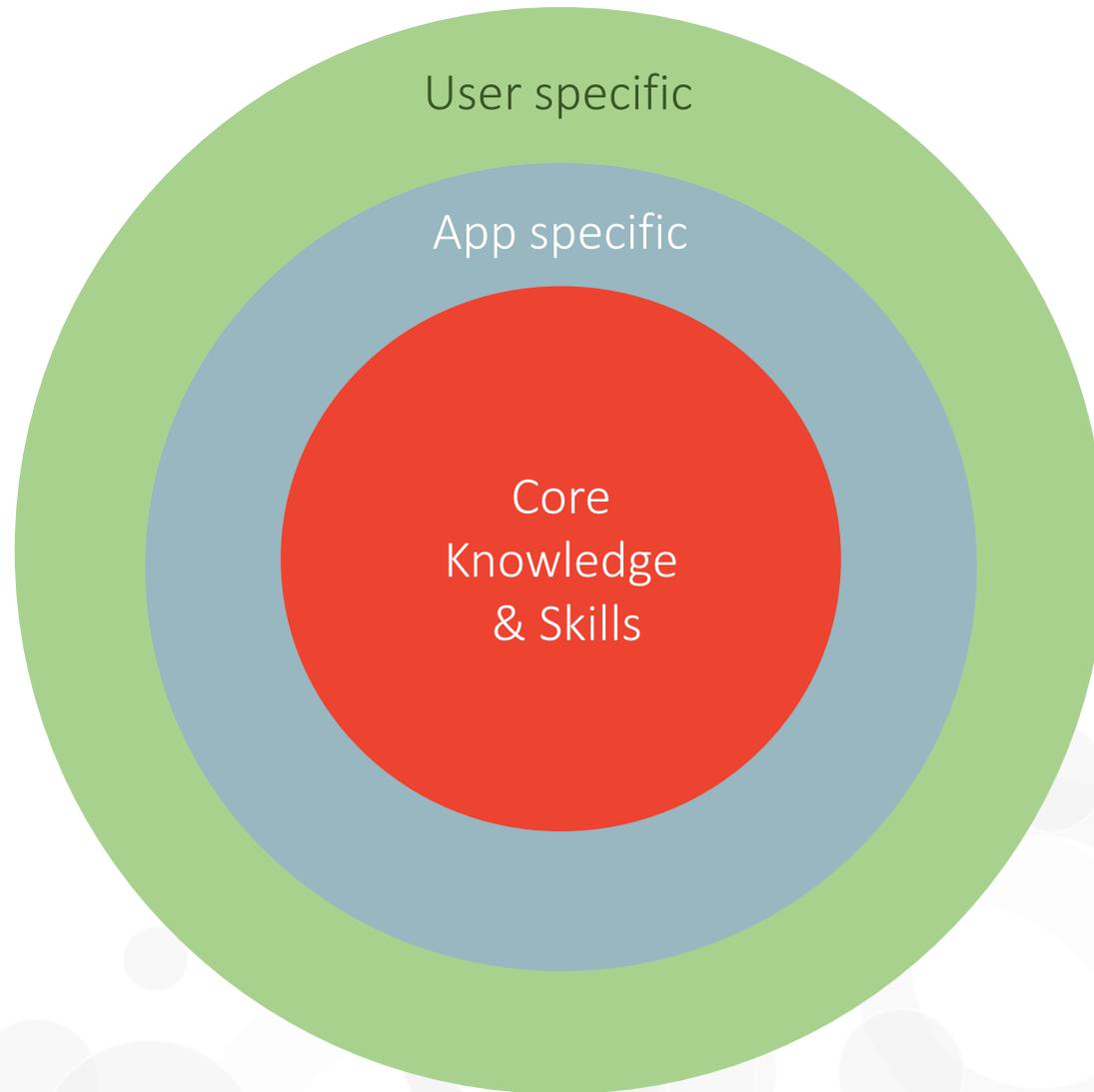
Key Differences

| | Chatbots | Aigo/ Third Wave |
|--------------------|--------------------------|----------------------------|
| General Learning | Batch. Offline | Interactive. One-Shot |
| Training Data | Very large. Labelled | Very small. Ontology |
| Comprehension | Shallow. Statistical | Deep contextual parse |
| Personalization | Hard-coded. Fixed | Extensive. Dynamic |
| Reasoning | None | Yes, plus disambiguation |
| Dynamic Context | Limited by training data | Real-time adaptive |
| Scrutability | Black Box | Fully scrutable |
| Knowledge & Skills | Hard-coded/ Read-only | Learns in real-time via NL |

Electric light bulbs did *not* come about from the continuous improvement of the candle

– Oren Harari

Aigo 'Brain' – At the Core



Existing apps benefit from
Core improvements!

Additional Info...

[Aigo.ai/demos](https://aigo.ai/demos)

[Aigo.ai/articles](https://aigo.ai/articles)

Peter Voss

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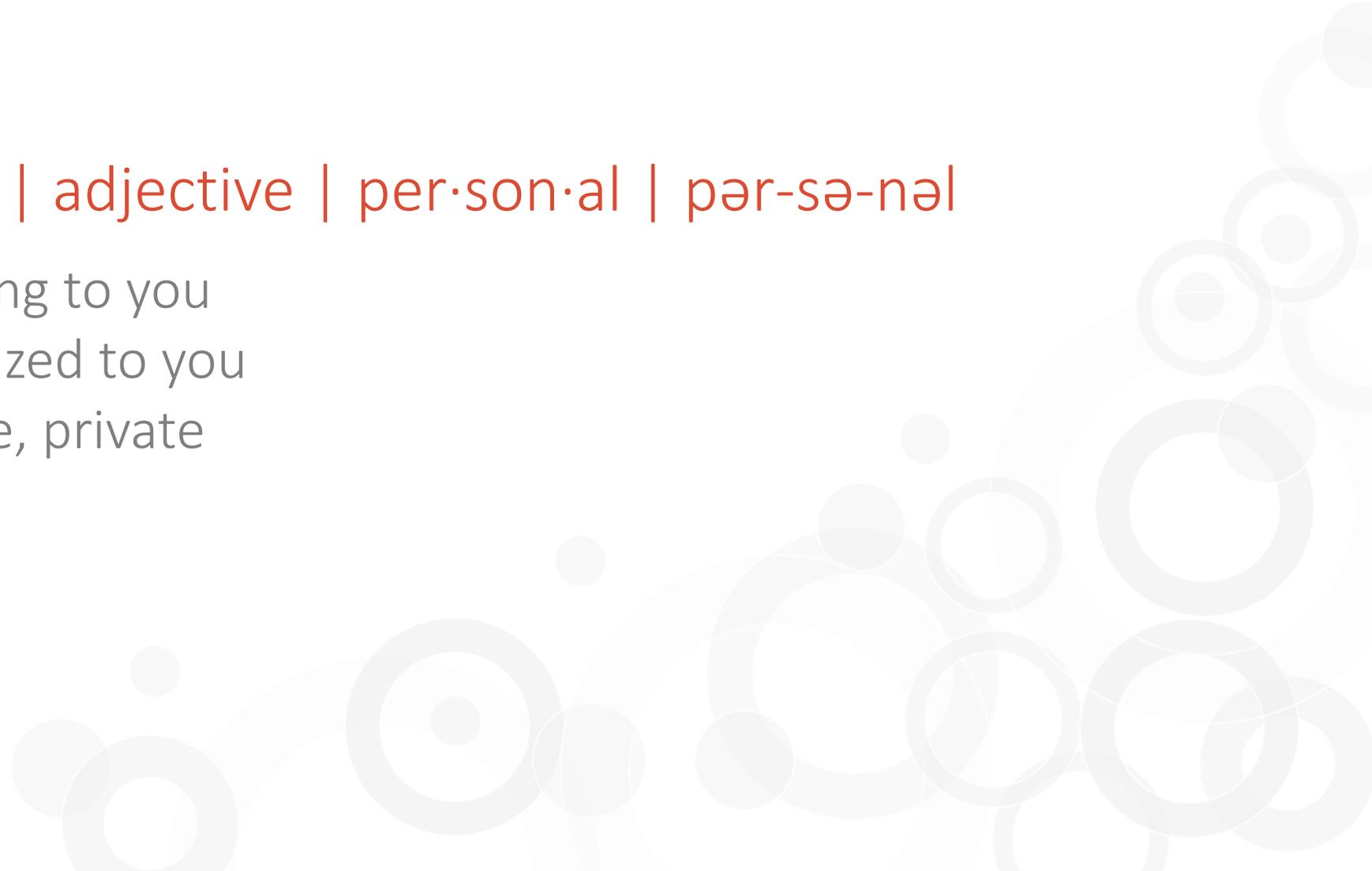


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aigo.ai

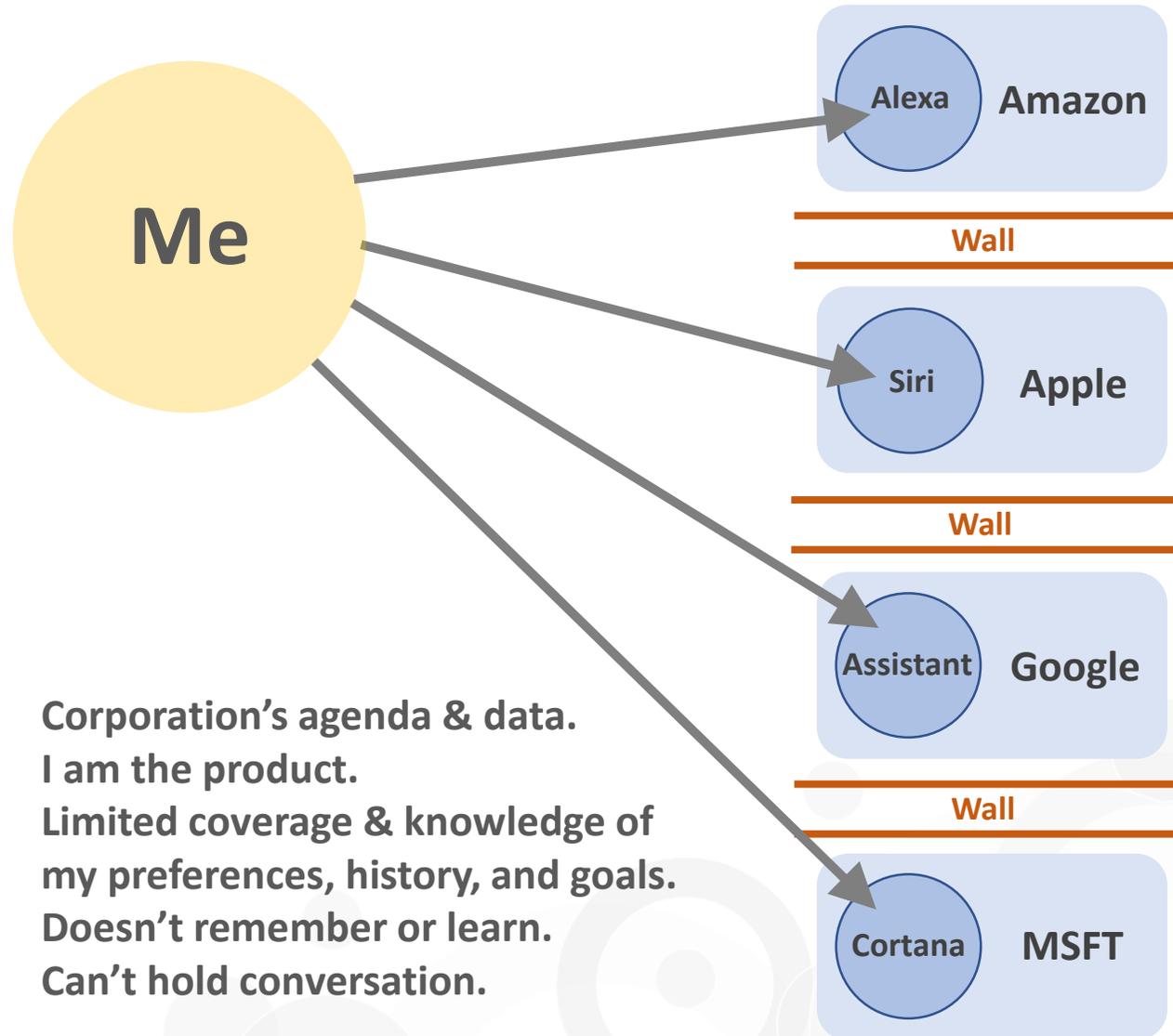
Personal personal assistant

Personal | adjective | per·son·al | pər-sə-nəl

1. belonging to you
2. customized to you
3. intimate, private

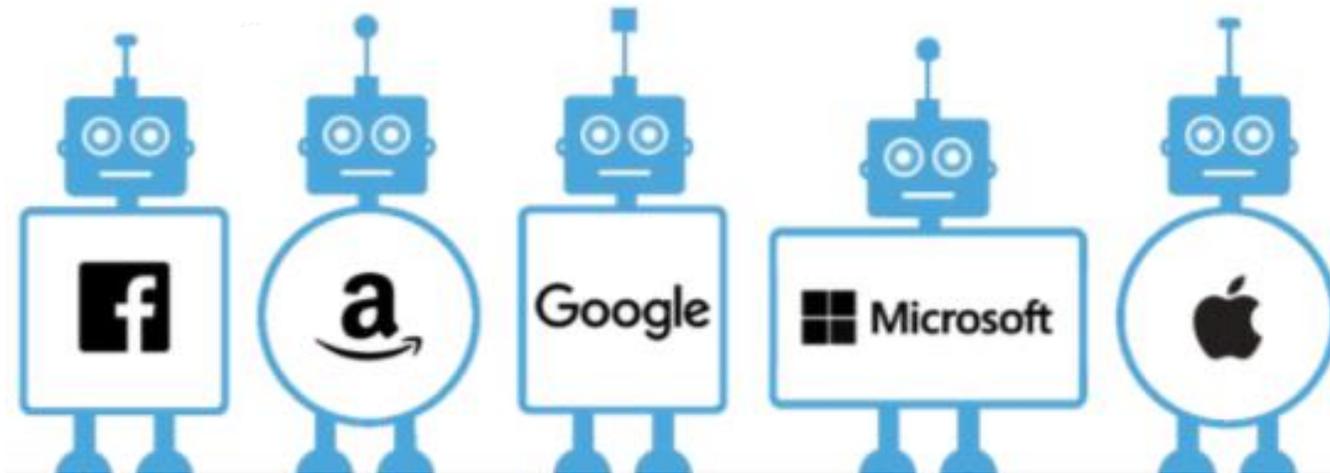


Today: My (Non-Personal) Assistants

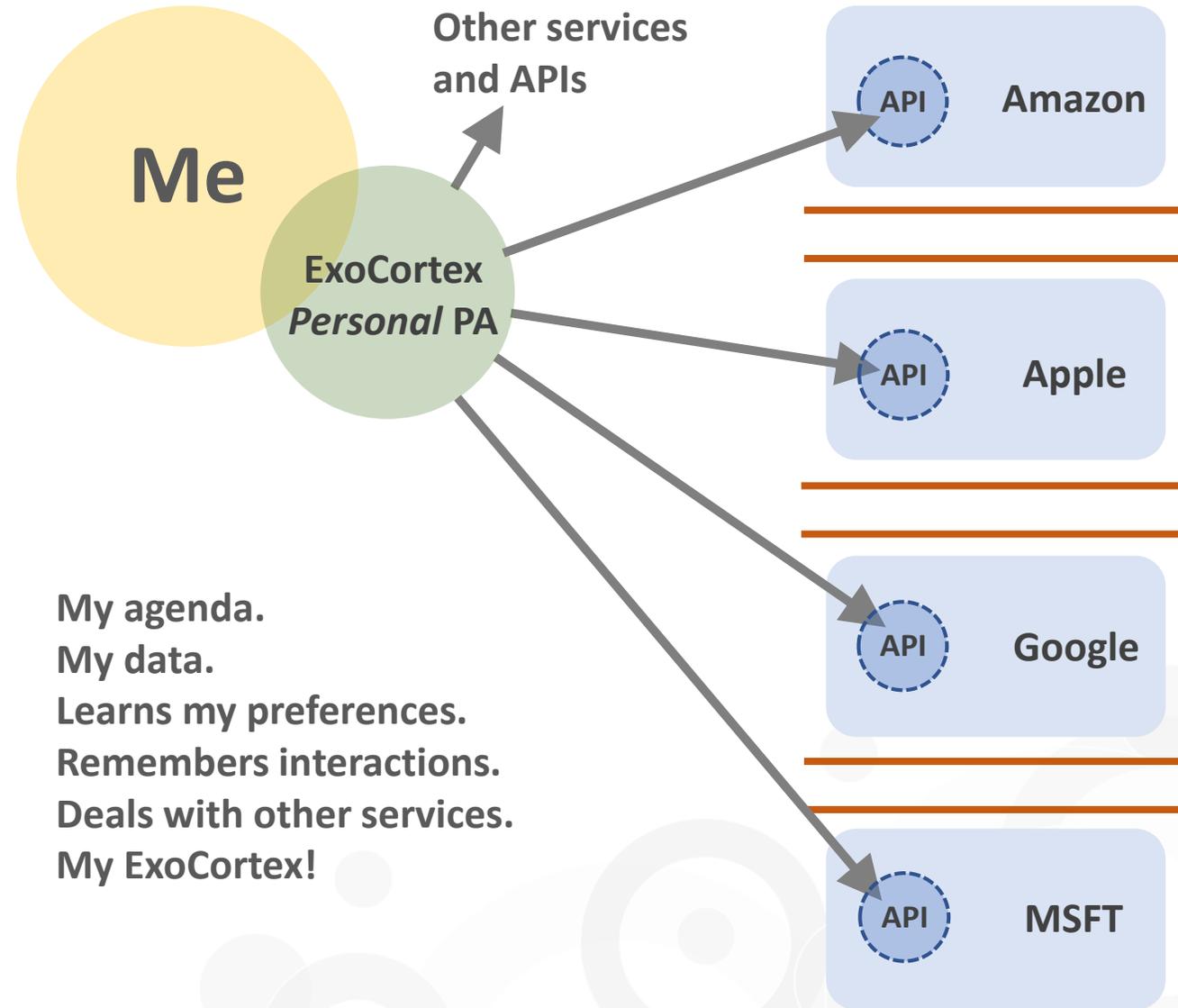


Corporation's agenda & data.
I am the product.
Limited coverage & knowledge of
my preferences, history, and goals.
Doesn't remember or learn.
Can't hold conversation.

Mega-Corporation's Agenda...



My ExoCortex: Personal Personal Assistant



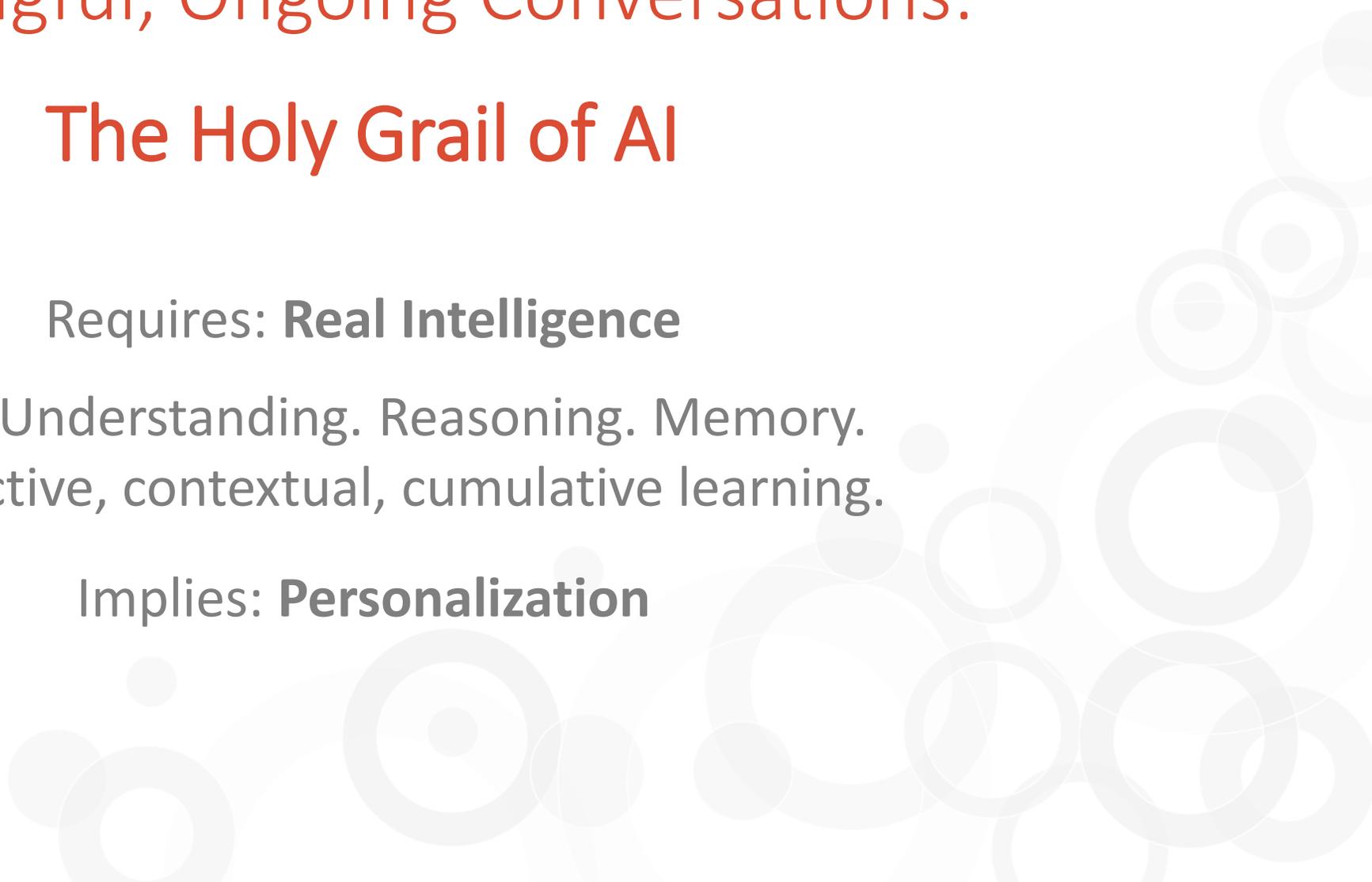
My agenda.
My data.
Learns my preferences.
Remembers interactions.
Deals with other services.
My ExoCortex!

Meaningful, Ongoing Conversations: The Holy Grail of AI

Requires: **Real Intelligence**

Deep Understanding. Reasoning. Memory.
Interactive, contextual, cumulative learning.

Implies: **Personalization**



Natural Language Understanding and Conversation are really hard

Multiple word meaning selection, tenses, plurals, conjugations

Nouns, adjectives, adverbs, verbs, auxiliaries, determiners, genitives

Preposition and clause attachment resolution, ditransitives

Pronoun and co-reference resolution, actor/ patient identification

Entities versus concepts, personas, proper nouns, names, titles, genders

Complex ontologies, inheritance (up & down), synonyms, antonyms

Space and time, scalars, mass nouns, data types, UOM, conversions

Relationships: space, time, relatives, cause-effect, compounds

Negation, and, or, (fuzzy) quantifiers, part-of, ownership

Implications, conditionals, contradictions, fuzzy values, certainty

Temporal information, patterns, sequences, analogy, same meaning

Meta-cognition, emotions, confusion, error recovery, disambiguation.....

| Aspects of language | Examples |
|---------------------------------|--|
| grammar types | 'Like' can be a verb, adjective, noun, preposition, or conjunction. |
| concept meaning/ selection | The game ended in a tie ; He is wearing a nice tie . Ted drew a bench towards the fireplace vs. Ted drew a bench by the fireplace. |
| phrases (verb & others) | John stopped by the house this morning |
| actor-patient/ ditrans. | email (to) the buyer the file |
| clauses | I want to run a marathon. (NounC); The data on file will be used for the project at hand, which is already under way. |
| preps | After 3 pm, I will eat the apple on the table; Phantom preps: I walked (for) three days (during) this week; (on) Sunday I will take a hike. |
| determiners | Basically every other person is blonde; We teachers know these rules that the union is referring to. |
| quantifiers | Sally won unlimited slices of pizza; Sally bought both extremely expensive china tea cups. |
| Noun-Adj-Adv-Det resolution | Grab some green apples and oranges. ('some' mods both, 'green mods 'apple' only). Television & movie stars vs royalty & movie stars. |
| scalars | numbers: 2, 5, 7; measurements: 10 lbs., 8 cm, 100 mph. |
| fuzzy values | fairly cheap; very expensive; exorbitant |
| pronouns | He sent her his resume. Tom walked his dog. |
| co-reference | Tom finished his research paper on bats last night. He got a good grade on the paper; Jim is in California. I will visit there soon |
| implied concepts (rNouns) | John brought a dozen cookies so I ate a few (r_noun); I saw no fewer (r_noun) than 10 cats. Order a large. |
| normalization - value | two and a half miles; let's meet at five to 7 |
| normalization - meaning | ask over/invite vs. ask/inquire |
| multiple encoding | email me; send me an email |
| data types | five-thirty in the afternoon; 7' 10"; 134 lbs. |
| attributes | ripe bananas are yellow ; Tom is tall and handsome . |
| entities | Jim Cezo and The Alliance Group purchased shares of Amazon . A car versus the car versus Jane's car versus cars. |
| compounds | The boys and girls competed together; Mr. and Mrs. Wilson |
| concept hierarchies | noun: KTM>motorcycle>vehicle>artifact; verb: go for>attempt>do |
| names (+complex) | Dr. Charles (Chip) Andrew Brown snr; The North American Society for Bat Research |
| negation | I don't like white wine; Don't schedule any meetings on Friday; Which fruits are not rotten? Who has no availability? |
| and/ or/ etc. | Birds in cages and boxes . vs. Birds in cages and dogs. |
| tenses (+aux) | I will send the email; I sent it; neeves are nice -- neeves = plural |
| pre/ suffix. Conjugations | Graham Thomas III is tall.; Cecilia Jr.; Dr. Hobbes; Mr. & Mrs. Wilson. Ex-accountant. Am, are, is, I, me, mine. |
| comparatives | I have more than 6 oranges; I have more oranges than John |
| conditionals | if we have a meeting over 3 hours, cancel my lunch |
| cause/ effect | Cameron turned the light off in the room. Now it is dark |
| reason | Why did Cameron turn off the light? (Because he was going to bed) |
| implication | Close the door. Is the door closed? |
| meta info & mood | Location/ situation/ goal/ mood of user. Agent confusion, urgency, boredom. |
| genitives | My first car's original engine's carburetor... |
| relationships | The teacher of my brother, Steve, is Jane. My favorite aunt lives in France. |
| temporal info | Frank went to Sally's house. After that he returned home. Where is Frank? |
| spatial info | I looked inside the closet behind the door of the house |
| time/ date | John's party is 5 days after Christmas ; |
| ownership | Anna got flowers. She gave them to Jane. Who has the flowers? |
| part-of | Jim is the pitcher on our team; Wheels are part of an automobile. |
| superlatives/ min/ max | Dogs are my favorite ; The blue whale is the largest mammal. |
| synonyms/ antonyms | Giving a hug is the same as hugging; The opposite of nocturnal is diurnal; sell-buy |
| homonyms | flower/ flour |
| analogy | carrot is to vegetable as apple is to what? |
| metaphor | The world is an oyster. |
| spelling errors | I installed the secrutiy camera here to catch theives (context can help correct 'secrutiy' to 'security' & 'theives' to 'thieves') |
| grammar errors | We went to Texas to see family friends. After we arrived their Henry greeted us. (Context can help prefer there over their) |
| partial sentences | at 5 AM; in Redondo Beach; Sara is; the store on Wednesday. |
| exclamations/ courtesies | wow! Thank you so much!; That is, omg, disgusting! My brother, geeze, wont get a job! |
| error recovery | Henry's appointment does not exist, create? |
| date / time / timespan resoluti | Jim has soccer practice 3 weeks from Tuesday. The event will last 4 hours. |

Levels of Understanding and Learning we should expect from AI

Remind me to speak with Jane. (reminder)

Remind me what did Jane say? (tell me)

Remind Jane to talk to me. (ask Jane)

(Different meanings and responses to 'remind')

My sister's cat Spock... is pregnant.

(A five-year old immediately learns 5 new facts)

Challenges for Conventional 'NL' Technology

I arrived at **my favorite hotel** 3 hours **after** my last client meeting.

Let's have breakfast (dinner). I discovered a new restaurant at 405 Main. Meet **us there** at **7**.

Tom **almost** sent **those** email to his newest employee, **Paul**. I only read **two**.

If **Paul's boss'** birthday **is after** the next staff meeting, bring some popcorn.

I used the copier in the hall, Jane **the one** in dispatch. **Mine** kept jamming.

They sold the property to their biggest customer. Who **bought** it? Who **owns** it now?

He **left** the watch at the office. He **left** her the watch. He left the **watch** at 5 am.

The preferred mode of communication to **clients** is **email**. John sent **emails** to a **client** as told.

Challenges for Conventional 'NL' Technology

We received one package yesterday, and **another two** today. The **first one** was damaged.

Sarah ducked. Sarah has a duck. We saw her **duck**.

She **lives down** her achievements. What does she **downplay**?

The meeting is **on** tonight. The meeting is **on** Friday.

Breakfast is at **8**. Let's meet for dinner at **8**.

How many people? What time is the reservation? **For 2**.

They read books **on** horses.

I **need** Jane to go. I **need** the car to go.

Challenges for Conventional 'NL' Technology

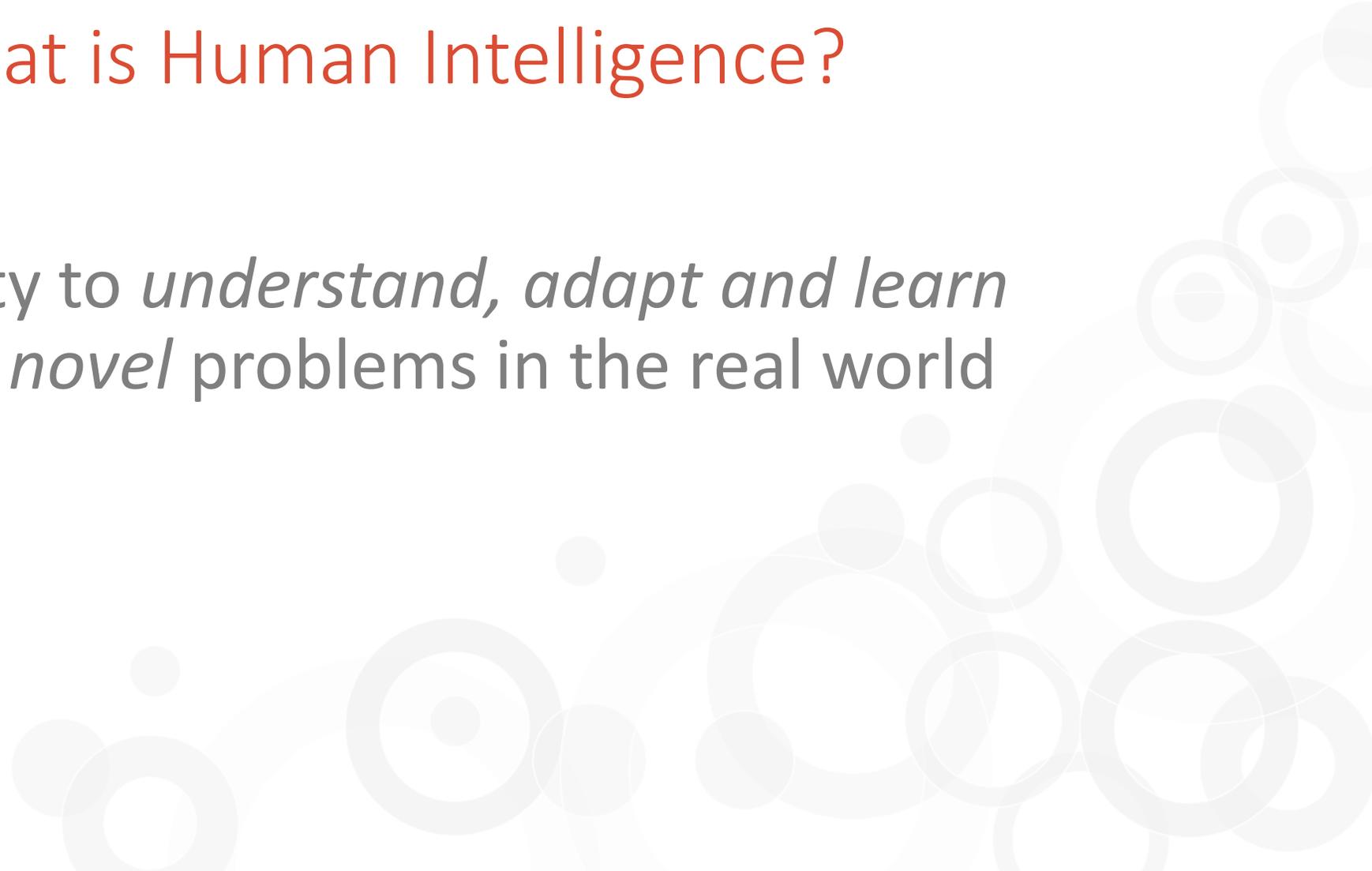
Dell considers costs such as librarian assistance, photocopy charges, rent, and supplies to be the firm's overhead. **Will the client pay for copying?**

In the selection of counsel, as in its own employment decisions, Dell is committed to equal opportunity and fair treatment for all lawyers and law firms without regard to race, color, religion, national origin, sex, sexual orientation, age, disability, veteran status, or any other characteristic protected by law.

Dell expects outside counsel to use its best efforts to minimize reimbursable out-of-pocket costs both by avoiding unnecessary expenditures and by taking advantage of volume discounts and bulk arrangements that may be available.

What is Human Intelligence?

The ability to *understand, adapt and learn* to solve *novel* problems in the real world



Key Requirements of Intelligence

| Intelligence Requires | Wave 2 ML / DL  | Wave 3 Cognitive  |
|-----------------------------------|---|---|
| General Real-time Learning | ✗ | ✓ |
| Self Directed Learning | ✗ | ✓ |
| Dynamic Goals, Memory and Context | ✗ | ✓ |
| Transfer Learning/ Generalization | ✗ | ✓ |
| Abstract Reasoning/ Language | ✗ | ✓ |

Electric light bulbs did *not* come about from the continuous improvement of the candle

– Oren Harari



Narrow AI – 1st and 2nd Wave/ ML

Frozen, *External* Intelligence



AGI – 3rd Wave/ Cognitive Architectures

Adaptive, *Internal* Intelligence

Adaptive Intelligence

